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Published in *Nutrition Reviews* 80:5 (2022), pp. 1247–1273; doi: 10.1093/nutrit/nuab123
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Correlates of Children's Dietary Intake in Childcare Settings: A Systematic Review

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Abstract

Context: Children consume up to two-thirds of their daily dietary requirements in full-time childcare, making the setting a critical vector for preventing childhood obesity. *Objective:* To summarize the ecological correlates of children's dietary intake in childcare settings that were identified and categorized using the Six-Cs developmental ecological model of contributors to overweight and obesity in childhood. *Data Sources:* A literature search was conducted in 4 electronic databases. *Study Selection:* English-language, peer-reviewed publications that investigated at least 1 correlate of children's (ages 2–6 years) dietary intake in childcare settings and measured children's actual consumption of foods and beverages from food groups were included. *Data Extraction:* Correlates were categorized into child, clan, community, and country groups. *Results:* A total of 55 studies, which examined 29 correlates, were reviewed. Correlates identified included child's age, sex, characteristics of food provision (namely, food composition, foods and beverages served, portion sizes), repeated exposure, nutrition education, book reading, peer influence, meal service type, and childcare teachers' responsive feeding practices. Policies and participation in Head Start and the Child and Adult Care Food Program could not be determined as correlates of children's dietary intake, owing to a lack of evidence. *Conclusion:* This review produced a list of correlates to consider in designing interventions to improve children's dietary intake in childcare settings. The correlates could contribute to development of lifelong healthy eating habits, thereby preventing childhood obesity.

Keywords: childcare settings, dietary intake, food groups, fruits and vegetables, preschool children

Introduction

Dietary intake in early childhood is critical for optimal growth, making it an important target for obesity prevention.[1,2] Children consume between one-half and two-thirds of their daily dietary requirement while attending full-time childcare.[3] In childcare settings that follow the federal Child and Adult Care Food Program (CACFP) nutrition standards in the United States, children are served fruits, vegetables, whole grains, protein, and milk during meals and snacks.[4] However, studies have reported that despite complying with the federal nutrition standards, age-specific dietary recommendations are not being met in childcare settings.[5–7] Therefore, a better understanding of contributors to poor diet quality in this population group is important.

There has been a steady increase in the number of empirical evidence and systematic reviews over the past decade describing the role of the childcare setting in the development of children's eating habits and childhood obesity prevention.[8–14] Specifically, researchers have reported a variety of socioecological factors that are correlated with children's dietary intake in childcare. These factors include childcare teachers' mealtime practices,[14–17] foods served to the children, and classroom-based nutrition education.[12,15,18] In a systematic review evaluating the impact of healthy eating interventions in childcare, the authors emphasized comprehensive interventions targeting multiple ecological levels rather than single-level interventions.[19–21] However, although many (~63%)[19] childhood obesity prevention interventions in childcare settings targeted children's diet as an outcome, a systematic review using a guiding framework determining correlates of or focusing on factors related to children's dietary intake in childcare settings is yet to be found in the relevant literature, to our knowledge.

Understanding ecological factors in detail helps researchers pinpoint modifiable risk factors of children's dietary intake for targeted interventions and resources. The Six-Cs developmental ecological model of contributors to overweight and obesity in childhood has been previously used in a book chapter[22] and a systematic review[23] to explain children's dietary intake. Originally, the model was created as a guiding framework to understand multiple potential risk factors for childhood obesity.[2,22,24] The model describes how potential correlates might affect childhood obesity outcomes via their interconnected and hierarchical stages of influence across 6 ecological levels (i.e., cell, child, clan, community, country, and culture).[24] Though this model is a derivative of Bronfenbrenner's socioecological model,[25] the Six-Cs developmental ecological model provides more nuance to characterize the different levels within the socioecological model, making it more relevant to the present research topic. In the Six-Cs developmental ecological model, the cell and child correlates represent the individual level of Bronfenbrenner's socioecological model; the clan correlate represents the microsystem (i.e., structures that have direct contact with the child); the community correlate represents the exosystem (i.e., the larger social system within which the child does not function directly); and last, the country and culture correlates represent the macrosystem (i.e., cultural values, customs, and laws) (Figure 1).[22,26] Consequently, given the literature gap and importance of a framework, the Six-Cs developmental ecological model is well suited to organize correlates of children's dietary intake in childcare settings. Furthermore, this adapted model could assist in successful development

of multilevel targeted interventions and research pertaining to children's dietary intake in childcare settings. In the context of the present review, childcare settings include childcare centers, family childcare homes, and preschools.[27]

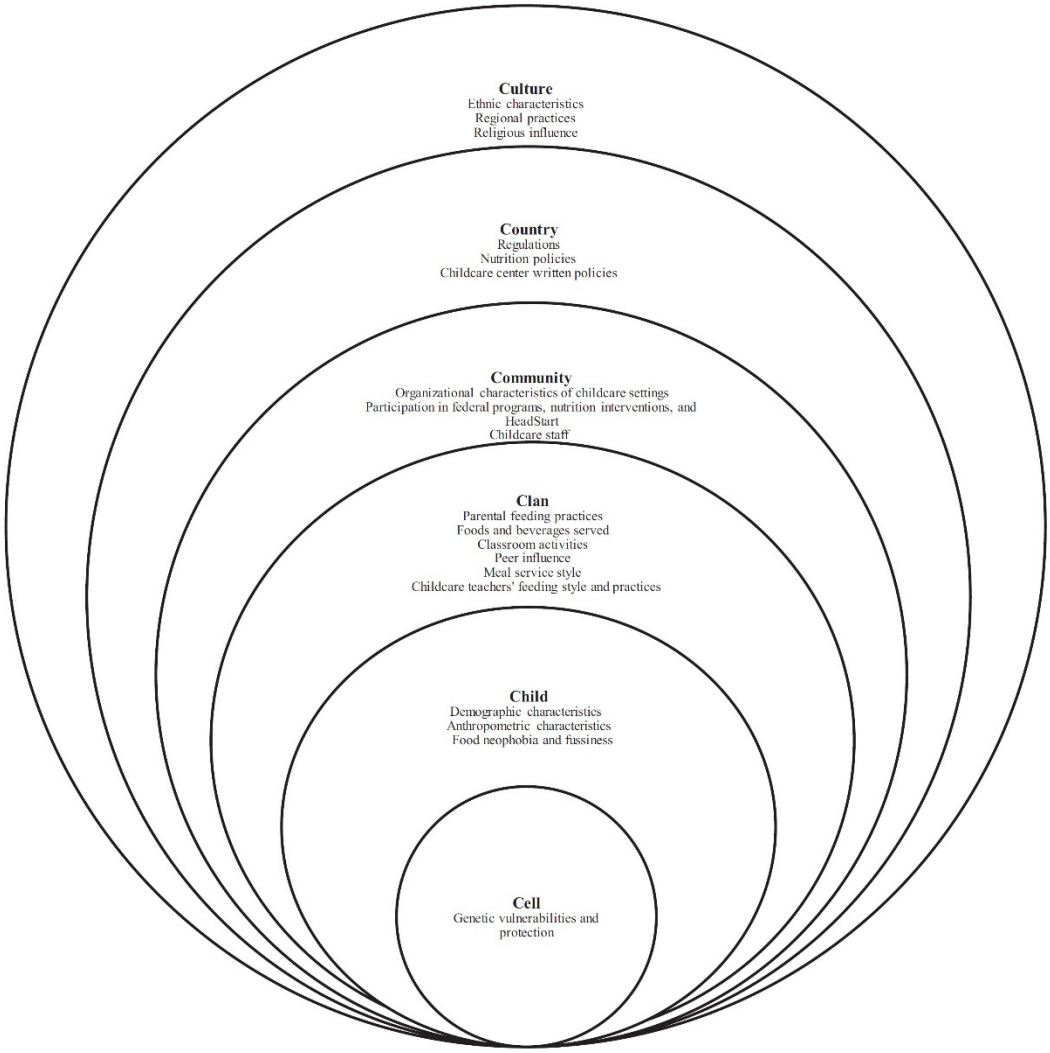

Figure 1. Six-Cs developmental ecological model of correlates of dietary intake in childcare settings (adapted from Harrison et al.[24]).[22]

Dietary intake in research studies has been defined using various standards for categorizing food, such as the Healthy Eating Index,[28] MyPyramid,[7] and CACFP food groups.[5] In addition, consumption of micronutrients,[7] macronutrients,[29] and specific healthy familiar foods or novel foods (e.g., *mooli*, also known as Daikon Radish)[30] also have been reported. For this review, we used the definition provided for the US Department of Agriculture CACFP food groups categorization to extract children's dietary intake data from the studies

we reviewed.[4] CACFP is a federal food assistance program that regulates nutrition standards for participating childcare settings in the United States. These childcare settings serve 4.6 million US children daily. Moreover, due to the program's success and importance, 19 US states (namely, Washington, Utah, New Mexico, Alaska, Arkansas, South Carolina, North Carolina, Rhode Island, Colorado, Montana, Minnesota, Iowa, New York, Connecticut, New Jersey, Hawaii, Louisiana, Oklahoma, and Georgia) require all state-licensed childcare settings to follow CACFP nutrition standards regardless of their participation in the program.[31,32] CACFP food groups also were considered as a reference in the present review, because CACFP provides detailed nutrition standards and age-specific serving-size requirements for meals and snacks served in the childcare settings.[4] Last, the CACFP nutrition standards were revised recently for national implementation to keep the standards consistent with (1) appropriate authoritative scientific agency and organization recommendations, while being sensitive to cost and practical application; (2) the most recent and relevant nutrition science; and (3) the most recent version of the Dietary Guidelines for Americans.[33]

Our objective for the present systematic review was to identify correlates of children's dietary intake in childcare settings as defined by the CACFP food groups and to organize the correlates using the Six-Cs developmental ecological model of contributors to overweight and obesity in childhood.

Methods

Protocol registration

This review was conducted under a protocol registered with the International Prospective Register of Systematic Reviews (PROSPERO; registration no. CRD42019125847).[34] The guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)[35] (Figure 2) as well as the PROSPERO registration system[34] were used to ensure the transparency of the review process and to strengthen confidence in findings (Table S1).

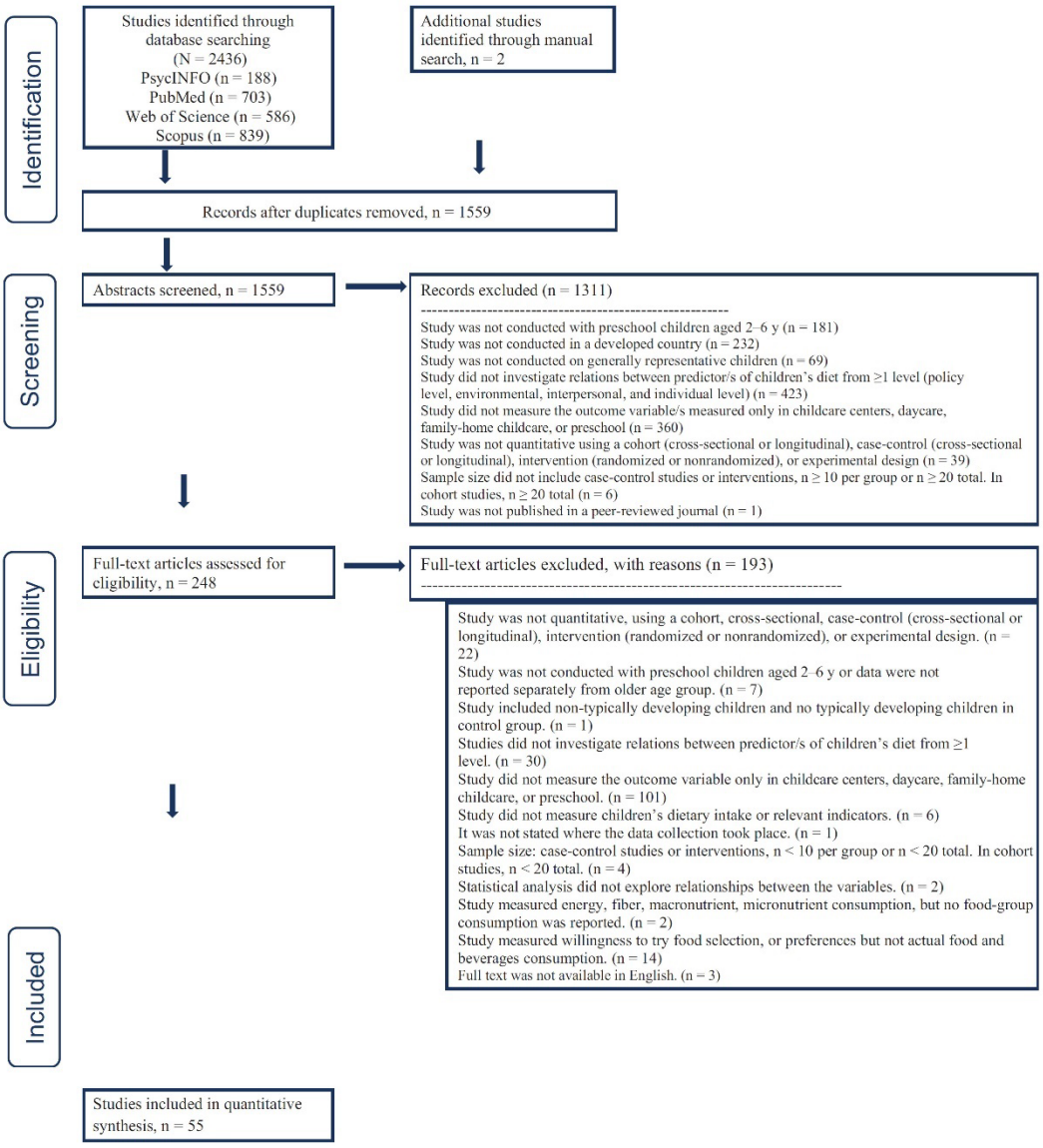

Figure 2. Study selection flowchart based on Preferred Reporting Items for Systematic Reviews and Meta-Analysis[35] guidelines.

Criteria for considering studies for this review

The PICO (population, intervention, comparison, outcomes) framework[36] (Table 1) was established to formulate the systematic review research question and to determine the inclusion and exclusion criteria for studies (Figure 3).

Table 1. PICO criteria for the inclusion of studies

Criterion	Description
Population	Children aged 2–6 y without any special physiological and psychological condition, for instance, children with overweight or obesity, homeless youth, acutely ill or institutionalized individuals, adult participants, children with chronic diseases, developmental disability, autism spectrum disorder, avoidant or restrictive food intake disorder
Intervention	Any quantitative cross-sectional or experimental study examining correlate(s) of children's dietary intake while attending childcare settings
Comparison	Not applicable
Outcome(s)	Children's dietary intake from food groups (fruits, vegetable, beverages, whole grains, dairy, protein, sugary foods, desserts, and other snacks) listed in the Child and Adult Care Food Program policy and standard[4]

Inclusion Criteria	
1.	Quantitative studies reporting associations between predictors and dietary intake.
2.	Sample size must be at least n ≥ 10 per group or n ≥ 20 total.
3.	Studies conducted on generally representative population, normally developing as well as picky eaters, children with food neophobia.
4.	Studies investigated relations between predictor/s of children's diet from ≥ 1 of the Six-Cs developmental ecological model levels: cell, child, clan, community, country, and culture.
5.	Children's dietary intake of food groups (fruits, vegetable, beverages, whole grain, dairy, protein, sugary foods, desserts, and other snacks) mentioned in the CACFP policy guidelines, were measured while the child was in the childcare setting.
6.	Children's actual consumption of the foods or plate waste in the childcare settings was reported.
7.	The methods for the data collection need to be peer reviewed, validated, and standardized.
8.	Studies conducted in developed countries, classified as high income using 2019 data from the World Bank, currently having a gross national income of ≥ US $12,536 per capita.[37]
9.	Sample included children aged 2–6 y.
10.	Studies conducted with humans.
11.	Full-text articles published in peer-reviewed journals in English from 1980 to January 2020.
Exclusion Criteria	
1.	Qualitative, review, case studies, or studies reporting only changes in dietary intakes and other variables.
2.	Sample size was < 10 participants per group or < 20 total.
3.	Studies investigating dietary intake correlates in relation to eating disorders or any other disease conditions. Studies involving "special" groups of participants, for instance, children with overweight or obesity, homeless youth, acutely ill or institutionalized individuals, adult participants, children with chronic diseases, developmental disability, autism spectrum disorder, avoidant/restrictive food intake disorder.
4.	Multifactorial studies in which the effect of diet could not be separated from other factors. For example, if the dietary intake is included only in the lists of predictors and not analyzed as a criterion, then that study will be excluded.
5.	Study examining only menus, or energy, micronutrient, and macronutrient intake in childcare settings.
6.	Studies reporting children's food preferences, willingness to try, and willingness to select foods, and not actual consumption from the food groups.
7.	The study was executed in settings such as hospitals, home, school cafeteria other than childcare centers, daycare, family-home childcare, or preschool.
8.	Studies conducted in countries classified as "lower middle income" and "low income" using 2019 data from the World Bank, currently having a gross national income of < US $12,536 per capita.
9.	Studies in languages other than English, with no English translation provided. Study was published before 1980 and after January 2020.

Figure 3. Inclusion and exclusion criteria for the studies included in the systematic review. CACFP, Child and Adult Care Food Program

Population

The population of interest in this review consisted of typical 2–6-year-old children attending childcare settings, as well as childcare teachers and early childhood professionals. The term childcare teachers, as used in this article, refers to early childhood or childcare personnel who care for and have direct contact with children during mealtimes. Other terms found in the reviewed studies to identify a childcare teacher include childcare provider, caregiver, teacher, educator, or staff. Relevant studies conducted in countries with high-income economies (i.e., a gross national income ≥ US$12,536 per capita according to World Bank data)[37] were included to maintain consistency for some demographic characteristics.

Types of intervention

Cross-sectional, cohort, and pre-post intervention studies without a control, and randomized controlled trials investigating children's dietary intake in childcare settings were considered (Figure 3). Intervention studies were included if an evaluation of program impact was children's dietary intake for food groups in childcare settings.

Outcome measure

The outcome measure was children's dietary intake as defined by the CACFP food-group categories: fruits, vegetables, beverages, whole grains, dairy, proteins (meat and meat alternatives), sugary foods, desserts, and other snacks (e.g., crackers).[4] Studies were included if correlates of children's actual consumption (e.g., Healthy Eating Index, 24-hour food recall) or plate waste for food groups, or both were reported. Studies relating results for nutrients and energy consumption (rather than food groups), children's food preferences, willingness to try, willingness to select foods, and no actual consumption of foods were excluded. In the present review, the term *dietary intake* indicates both quantity and quality of the food groups and beverages consumed.

Search methods for identification of studies

The first author consulted an experienced librarian to create search strings and guidelines to use in the following databases: PsycINFO, PubMed (Medline), Scopus, and Web of Science Core Collection. This search strategy combined key terms for factors or correlates with key terms for dietary intake and/or nutrition. Studies in the databases were identified that included any of the search string terms as their keywords, Medical Subject Heading terms, and/or in their abstracts and title sections. Within each search category, all key words and Medical Subject Heading terms were combined using the Boolean operator OR, and the results were subsequently combined with the Boolean operator AND. The full search string is provided in Appendix S1. Final searches were limited to the following categories: English language, humans, publication years (January 1990–January 2020), and child age (2–6 years old) categories. Two additional studies were identified through a manual review of related research. Duplicates were removed from the search, using Zotero citation manager (version 5.0.80).[38]

Data collection and analysis

Selection of studies

Studies identified by the search were imported into DistillerSR (Evidence Partners, Ottawa, Ontario, Canada)[39] for screening and data extraction. The first author and a research assistant (trained and experienced to conduct literature reviews) each independently screened and coded approximately 50% of the abstracts and titles. A structured form was designed to filter the abstracts on the basis of the inclusion and exclusion criteria (Figure 3). Each question on the form had 3 answer choices: yes, no, and cannot be determined. The form was tested and reviewed by 2 coauthors (J.A.S., D.A.D.), who are experts in the relevant field. Approximately 25% of all abstracts were double coded by another research assistant (trained and experienced in conducting systematic reviews) to ensure that the inclusion and exclusion criteria were applied consistently. The first author and the other coders used a verbal consensus process to resolve any inconsistencies.

Data extraction and management

The first author extracted information from the included studies using an electronic template in DistillerSR.[39] Extracted information included author names, publication year, study location, type of childcare settings, population characteristics (namely, age, sex, race or ethnicity, sample size, weight status), potential and actual correlates, and outcome data related to children's dietary intake (Table 2). If a study examined > 1 potential correlate, each of the potential correlates was included in the analysis. These potential correlates were organized on the basis of each level of the Six-Cs developmental ecological model, using the definitions listed in Table 3.[24] Correlates studied in ≥ 3 studies are indicated in Table 3.

Risk of bias

Risk of bias of the selected studies was evaluated using the National Heart, Lung, and Blood Institute risk-of-bias assessment tool.[91] We chose this tool because it is study-design specific and allows reviewers to categorize the reviewed studies while focusing on concepts used to carefully and systematically assess the internal validity of a study.[91] The first author conducted risk-of-bias assessment for all included studies. For 25% of the studies, risk of bias was double coded by another research associate. Discrepancies were resolved by verbal consensus. Studies were scored as having low, moderate, or high risk of bias. No studies were excluded at this stage.

Table 2. Summary of the studies examining correlates of children's dietary intake in childcare settings ($N = 55$)

Reference; country	Sample size: no. of childcare centers; no. of children	Child characteristics: age: range, mean (SD); sex (%); race/ethnicity (no.); weight status	Measure of dietary intake	Potential dietary intake correlates	Key findings
Cross-sectional studies					
Gubbels et al. (2015)[12]; the Netherlands	24; 398 children	1–4 y, 2.25 (0.83); boys (50.8%); NR; NR	Recorded by childcare staff	Feeding practices	Explaining food preparation and providing stimulation to eat were positively associated with fruit and vegetable intake, respectively. Lower intake of sweet snacks was associated with child involvement in food preparation and staff giving child food without asking. Staff eating together with children was associated with greater intake of sweet snacks and lower intake of sweet drinks.
Hughes et al. (2007)[40]; United States	13 Head Start centers; 50 childcare teachers; 549 children	3–5 y, NR; boys (53%); Black and Hispanic (549); NR	Repeated weighing and plate waste	Feeding style	Vegetable, dairy, and entrée consumption was positively associated with indulgent feeding style. Dairy intake was positively associated with authoritative feeding style.

Table 2. *Continued*

Kakietek et al. (2014)[41]; United States	106 Licensed childcare centers[a,b]	3–4 y, NR; NR; NR; NR	Classroom observation	Policy, type of childcare	Compliance with policy regulations, being CACFP participants, Head Start centers, and participating in nutrition-related interventions were associated with consumption of low-fat milk (< 1%) and fewer sugar-sweetened beverages. CACFP participation was negatively associated, and policy compliance was not associated, with water consumption. Eat Well, Play Hard program participants were more likely to have children consuming milk with > 1% fat and consuming lower amounts of sugar-sweetened beverages than were other centers.
Kharofa et al. (2016)[16]; United States	Licensed, full-time, childcare centers (n = 30; for-profit, 40%; religious-affiliated centers, 30%; Head Start centers, 27%). 83% CACFP participants; 349 children	3–6 y, 4.3 (0.7); boys (48%); White (42%), Black (41%), other race (17%); mean (SD) BMI[b] z-score, 16.4 (1.8)	DOCC[b]	Feeding practices	Family-style service and sitting together with children predicted greater intake of fruits and vegetables. Having general conversation predicted less vegetable intake. Modeling healthy eating was associated with greater vegetable intake. Staff encouraging new or less-preferred foods, giving child second helpings, talking with children were not significantly associated with consumption of fruits and vegetables.
Kranz et al. (2011)[42]; United States	2 Local, full-time, state-accredited childcare centers; 41 children	2–5 y, NR; boys (46.3%); predominantly White; NR	Plate waste	Preference	There were no significant differences between the mean amounts of snack intake by children who reported they liked the snack and children who reported neutral preference/did not like the snack.

Table 2. *Continued*

Lehto et al. (2019)[43]; Finland	58 Public preschools; 585 children	3–6 y, 4.7 (0.9); boys (53%); Finnish; NR	Diary records by staff	Sociocultural factors and feeding practices	Presence of written food policies predicted higher vegetable consumption. Having ≥ 2 cooperation challenges with catering services were associated with lower fruit intake. Type of facilities for food preparation in the kitchen was associated with higher fruit intake.
Rollins et al. (2014)[44]; United States	1 University-based, full-day childcare center; 33 children	3–5.8 y, 4.5 (0.7); boys (33.3%); White (75.9%), Asian (12.1%), Black (3%), not specified (9%), Hispanic (12.1%); mean (SD) BMI percentile, 50.7 (28.6)	Weighing	Relative reinforcing value, hunger, BMI, age, sex	Total food consumed as reward-driven responses was positively associated with children's age, male sex, baseline hunger, and ab libitum intake during regular snack time of 2 differently shaped graham crackers. Food as a reward-driven response rate/min was positively associated with BMI z-scores, ad libitum intake, and reward sensitivity.
Surette et al. (2017)[45]; Canada	19 Licensed full-time childcare centers; 327 children	3–5 y, 4.1 (0.9); boys (51.1%); NR; mean (SD) BMI (kg/m^2), 20.7 (3.8)	Plate waste	BMI and WC	Food reluctance score meaning, the amount of plate waste of 5 food groups (fruits, vegetables, milk and milk alternatives, grains, meat and meat alternatives) was negatively associated with BMI of children but not associated with WC.
Tovar et al. (2019)[28]; United States	133 Family childcare homes (CACFP participants, 91.6%); NR	NR, 3.3 (1.2); boys (50.7%) NR; NR	DOCC	Feeding practices and style, sex	Indulgent feeding style and coercive-control feeding behaviors were negatively associated with child's HEI score. Autonomy support feeding style and male sex were positively associated with child's HEI score. Negative role modeling, teacher's race, and hours spent in childcare were not associated with child's HEI score.

Table 2. *Continued*

Vaughn et al. (2017)[46]; United States	166 Family childcare homes (CACFP participants, 91%); 496 children	1.5–5 y, NR; NR; NR; NR	DOCC	Nutrition environment, foods and beverages served, feeding environment, practices, menus, nutrition education, professional development, and nutrition policy	Foods provided to the children, nutrition education, professional development of the childcare teacher, and nutrition policy of the childcare setting were positively associated with child's HEI score. Beverages provided to the children, feeding environment, feeding practices, and menus were not associated with child's HEI score. Overall nutrition environment score was positively associated with child's HEI.
Ward et al. (2017)[47]; Canada	23 Full-day childcare centers; 238 children	3–5 y, 4.0 (NR); boys (52%); NR; underweight (5.7%), healthy weight (77.8%), overweight (13.7%), and obese (2.8%)	Digital photography and weighing	Peer behavior (mean baseline dietary intake)	The differences in average dietary intake of fruits and vegetables between each child and his or her peers became significantly less during the 9 mo from baseline. Thus, children's dietary intake was positively associated with the average of their peers' dietary intake.
Ward et al. (2017)[48]; Canada	50 Licensed, full-day childcare centers; 730 children	4–4.1 y, 4.0 (0.7); boys (52.3%); NR; mean (SD) BMI (kg/m^2), 20.2 (3.7).	Plate waste and digital photography	Feeding practices	Satiety recognition, verbal encouragement, and total nutrition practices score were not associated with children's dietary intake of vegetables and fruits (with and without potatoes).
Pre-post intervention study (without control group)					
Ahern et al. (2014)[49]; United Kingdom	3 Local nurseries; 42 children	1.3–4.7 y, NR; NR; NR; NR	Weighing	Repeated exposure (6–8 times) and flavor learning	Repeated exposure and flavor-flavor learning strategies increased the consumption of the 2 target vegetables, compared with the control vegetable, which was neither repeatedly exposed to the children nor mixed with preferred flavor. There was no significant difference between the 2 intervention strategies.

Table 2. *Continued*

Ahern et al. (2019)[50]; United Kingdom	5 Local nurseries; 95 children	2–5 y, 3.62 (0.07); boys (55.8%); NR; mean (SD) BMI z-score, 0.85 (0.15)	Weighing	Repeated exposure	Children in the variety group consumed more mixed-vegetable snacks during postintervention, but there was no difference for the single-vegetable snack in this group. Children in the repeated exposure group ate more single-vegetable snacks than the mixed-vegetable snack during postintervention period.
Anzman-Frasca et al. (2012)[51]; United States	1 Independent, full-day, university childcare center; 84 children	3–6 y, NR; boys (55.3%); group 1: White (84%), group 2: White (80%); group 1: overweight (24.4%), group 2: overweight (13.9%)	Weighing	Associative condition (serving vegetables with a dip or preferred dip), age, BMI	Consumption of target vegetables increased in both repeated exposure and associative conditioning (vegetables served with dip) groups; however, there was no differences between the effects of these 2 strategies. Older children ate more vegetables, and children with higher BMI ate fewer vegetables.
Araya et al. (1983)[52]; Chile	2; 240 children	2–4 y, NR; NR; NR; NR	Weighing	Energy density	For high-energy-density meal, amount of food consumed per kg of body weight and energy density of food was negatively associated.
Araya et al. (1999)[53]; Chile	1; 234 children	4–6 y, NR; boys (46.15%); Chilean; mean (SD) weight (kgs): boys, 20.8 (–2); girls, 20.6 (–2.3)	Weighing	Energy density of lunch meals	Serving high-energy-density meal was associated with lower volume of food intake, and low-energy-density meal was associated with greater volume of food intake. Lower-energy-density meal was associated with greater food intake at subsequent meal.
Araya et al. (2003)[54]; Chile	1; 35 children	5–6 y, NR; boys (48.6%); Chilean; BMI z-score range, –1.0 to + 1.0	Weighing	Carbohydrate and protein content of experimental meals	High-carbohydrate meal was consumed in higher amount compared with high-protein meal. High-carbohydrate meal consumption also was associated with greater amount of food consumed at subsequent meal.

Table 2. *Continued*

Bell et al. (2015)[55]; Australia	20 Full-time childcare centers; 216 children	2–4 y, 2.5 (0.4); boys (62%); NR; NR	Plate waste	Nutrition, hygiene, and food safety training of childcare staffs and menu modification	Children's consumption of grains, fruit, dairy, meat, and meat alternatives increased, but vegetable consumption did not change.
Bouhlal et al. (2011)[56]; France	3 Nurseries; 74 children	1.5–3.1 y, 2.5 (0.33); boys (43.2%); NR; mean (SD) BMI z-score, 0.2 (0.1)	Weighing and recording extra serving	Salt, fat, and sugar levels	More green beans and pasta were consumed when salt was added. However, adding fat to green beans and pasta did not alter consumption. Adding sugar to fruit puree did not increase its consumption.
Boyer et al. (2012)[57]; United States	1 Half-day childcare center; 21 children	Age: 2–5 y, NR; boys (52%); Asian (38%), White (62%); NR	Plate waste	Healthy version and shape of snacks	There was no significant difference in average snack consumption between the differently shaped and normal form of snacks.
Branen et al. (2002)[58]; United States	1 University-based childcare center; 39 children	Age: 3–5 y; NR; boys (48.7%); White (87.2%), Asian (7.7%), Native American (2.6%), Black (2.6%); NR	Observation and estimation	Form and major component of snack	There was no significant difference in children's consumption or waste of cute and regular-shaped snacks. Children ate the sweet snacks more than the other types of snacks served.
Carstairs et al. (2018)[59]; United Kingdom	1 Nursery; 43 children	3–5 y, 3.9 (0.57); boys (46.5%); White (96%); overweight (25.6%), mean (SD) BMI (kg/m^2), 16.5 (1.33)	Weighing	Portion-size alterations and serving 3 varieties of vegetables	Larger portion size was associated with greater intake of foods with high-energy density compared with smaller portion sizes. Offering vegetables did not result in lowering consumption from other food groups when larger portion size was offered. Serving variety of vegetables increased total intake of vegetables compared with single vegetable option.

Table 2. *Continued*

Fisher et al. (2003)[60]; United States	1 Full-day, university-based childcare center; 35 children	3–5 y, 4 (0.5); boys (48.6%); Black (2.9%), Asian (11.4%), non-Hispanic White (80%), Hispanic (5.7%); NR	Weighing	BMI, entrée portion sizes, eating at the absence of hunger/ overeating	Doubling the portion sizes of entrée increased children's entrée intake. Behavior of eating in the absence of hunger or overeating was positively associated with entrée intake. BMI was not significantly correlated with consumption.
Hägg et al. (1998)[61]; Sweden	1; 36 children	4.1–6.7 y, 5.2 (NR); NR; NR; mean (SD) BMI z-score, 16·2 (1.8)	Weighing	Meals served with milk or water	Serving milk with meals resulted in lower total amount of food intake compared with meals served with water.
Harnack et al. (2012)[62]; United States	1 Head Start center; 53 children	2–5 y, NR (NR); NR; Black (75.5%), American Indian (3.8%), mixed (13.2%), Hispanic/Latino (5.7%), non-Hispanic White (1.9%); BMI: < 85th percentile, 64.2%; 85th–94th percentile, 11.3%; > 95th percentile, 24.5	DOCC	Serving style	Serving fruits and vegetables first increased consumption of fruits and vegetables compared with other serving style, where fruits and vegetables were served along with other menu items. Grains, meat, and milk consumption increased, and fruits and vegetables consumption decreased when teacher-portioned meals were served compared with traditional family style.
Hausner et al. (2012)[63]; Denmark	5 Nurseries; 104 children (mere exposure group, *n* = 32; flavor-flavor learning group, *n* = 33; flavor-nutrient learning group, *n* = 39)	2–3 y, 2.4 (0.31); boys (47.1%); NR; NR	Weighing	Repeated exposure (mere e+xposure, flavor-flavor learning and flavor-nutrient learning strategies)	Children's consumption in both mere exposure and flavor-flavor learning groups increased from pre- to postintervention after 10 repeated exposures of unmodified and sweet artichoke purees. These 2 groups did not differ from each other, but both groups had higher consumption than children in the nutrient-flavor learning group, because this group did not consume a significantly greater amount of fat-added puree from pre- to postintervention.

Table 2. *Continued*

Kling et al. (2016)[64]; United States	3; 120 children	3–6 y, 4.4 (0.1); boys (50.8%); White (69%), Asian (21%), Black (3%), mixed or another race (7%); Hispanic/Latino (4%); mean (SD) BMI z-score: boys, 0.17 (0.15); girls, 0.22 (0.10)	Weighing	Energy density and portion sizes, sex	Children's total meal consumption increased with larger portion sizes but remained similar with energy density of the meals.
Kling et al. (2016)[65]; United States	4; 125 children	3–6 y, 4.2 (0.1); boys (53.6%); White (75%), Asian (15%), Black (3%), and mixed or another race (7%), Hispanic/Latino (8%); BMI percentile, 53.6 (2.4)	Weighing	Portion size and energy density of milk	Weight of milk consumed was associated with milk portion size. Total weight of foods consumed was associated with milk energy density but not with milk portion sizes. Both milk portion size and energy density were associated with the total weight of meal consumed.
Leahy et al. (2008)[66]; United States	1 Full-day childcare center; 61 children	3.1–5.6 y, (mean [SD]: boys, 4.5 (0.1); girls, 4.3 [0.1]); boys (49.2%); non-Hispanic White (63%), Asian (31%), Black (6%); mean (SD) BMI percentile, 62.5 (3.3)	Weighing and plate waste	Energy density of entrée	Portion size of entrée was not associated with energy intake and amount of vegetable consumption. Reducing energy density of entrée using pureed vegetables increased consumption of vegetables but did not increase the intake of other foods during the meal.
Leahy et al (2008)[67]; United States	1 Full-day, university-based childcare center; 26 children	3–5 y, 4.2 (0.1); boys (38.5%); White (57.7%), Asian (30.8%), Black (7.7%); mean (SD) BMI percentile: boys, 76.7 (5.2); girls, 68.4 (3.7)	Weighing and plate waste	Energy density	Manipulating meals to reduce the energy density had no effect on total weight of foods consumed. Boys consumed more food than girls; however, BMI was not associated with weight of consumed food.

Table 2. *Continued*

Leahy et al (2008)[68]; United States	1 Full-day, university-based childcare center; 77 children	2–5.5 y, 3.9 (0.1); boys (48.1%); White (69%), Asian (27%), Black (4%); mean (SD) BMI percentile, 64.6 (3)	Weighing and plate waste	Energy-density reduction	Lowering the energy density of an entrée did not have any effect on the total amount of food consumed. Children consumed more food in later part compared with the earlier part of the intervention.
Lowe et al (2004)[69]; United Kingdom	3 Primary schools; 402 children	4–7 y, NR; NR; NR; NR	Visual estimation and plate waste	Peer modeling videos and nonfood rewards	Children consumed more fruits and vegetables during 16-d intervention of peer modeling videos compared with the baseline phase during both lunch and snack time.
Lumeng et al (2007)[70]; United States	1 Full-day, university-based childcare center; 108 observations; 54 children	2.6–6.2 y, 4.2 (1.1); boys (68%); White (74%); NR	Counting from videotape	Group size	Group size of children eating together, and duration of snack time were positively associated with amount of snacks eaten. Moreover, the effect of group size existed only during long snack time and not during short snack times. Adult prompting rate was not associated with snack consumption. However, social interaction was positively associated with snack consumption.
Momin et al (2018)[71]; United States	5; 55 children	1–3 y, 2.1 (NR); boys (45.5%); Asian (1%), Black (49%); non-Hispanic White (30%); Hispanic/Latino (1.8%); other (7.2%); NR	Plate waste	Sensory-based exploratory behavior, parent-rated food fussiness	Neither parent-rated food-fussiness nor average frequency of sensory-based exploratory behavior nor manipulation (e.g., smelling, licking) were associated with hummus consumption.

Table 2. *Continued*

Norton et al. (2015)[72]; United States	1 University-based childcare center; 26 children	3–5 y, 3.9 (0.6); boys (50.6%); White (73%), Hispanic/Latino (11.3%), non-Hispanic/Latino (88.5%); mean (SD) BMI percentile, 62.2 (20.5)	Weighing	Portion sizes of beverage	Portion sizes of beverages were significantly associated with amount of beverage consumption.
Roe et al. (2013)[73]; United States	1 University-based childcare center; 61 children	3–5 y, NR; boys (47.5%); NR; BMI: > 85th percentile, 13%	Weighing	Serving variety of fruits and vegetables	Children selected and consumed more vegetables and fruit snacks when variety of types was served compared with a single type. Children selected and consumed fruit snacks more often than vegetable snacks.
Rollins et al. (2014)[74]; United States	1 University-based childcare center; 37 children	3.0–5.8 y, 4.5 (0.7); boys (35.1%); White (75.7%), Asian (13.5%), Black (0.03%), non-Hispanic (89.2%); mean (SD) BMI percentile, 55.3 (24.8).	Weighing	Past restriction, low inhibitory control, approach, and relative reinforcement value for foods	Children's food consumption was greater when the food was restricted for 5 min compared with when the food was not restricted. Past history of parental restrictions of snacks, children's inhibitory control, and relative values or motivation for food-directed reward were positively associated with greater food consumption. Parents' reports of child feeding practices and child's approach to food were not associated with the consumption.
Savage et al. (2013)[75]; United States	1; 34 children	3–5 y, NR; boys (47.1%); White (87%); NR	Weighing	Serving herb-flavored dip and plain dip with vegetables	Children were more likely to consume vegetables with a dip compared with eating the vegetable alone. The herb dip was preferred to the plain dip; however, the type of dip did not have any significant effect on vegetable consumption.

Table 2. *Continued*

Schwartz et al. (2015)[76]; United States	1 Head Start childcare center; 85 children	3–5 y, NR; boys (47%); White (36%), Asian (5%), Black (16%), mixed (37%), American Indian (5%); Hispanic (81%); overweight or obese (30%)	Weighing	Meal service style	Serving fruits and vegetables first before the rest of the meals did not increase consumption of fruits and vegetables consistently for different meals. However, serving milk before the rest of the meals and keeping it on the table throughout the meal increased milk consumption.
Smethers et al. (2019)[77]; United States	2; 46 children	3–5 y, boys: 4.3 (0.6), girls: 4.4 (0.6); boys (65.2%) White (74%), Asian (9%), mixed or another race (6%); Hispanic/Latino (13%); mean (SD) BMI z-score: boys, 0.01 (0.69); girls, 0.30 (1.01)	Weighing	Portion sizes	Increasing portion sizes of foods and milk led to greater total mean amount of food and milk consumption for 5 d.
Smethers et al. (2019)[78]; United States	3; 49 children	3–5 y, boys: 4.3 (0.7), girls: 4.3 (0.7); boys (65.2%); White (71.4%), Black (4.1%), Asian (8.2%), mixed race or others (10.2%), Hispanic/Latino (8%); mean (SD) BMI z-score: boys, 0.26 (0.83); girls 0.39 (0.83)	Weighing	Energy density	Energy density of foods was not associated with the total weight of foods consumed for 5 d. Moreover, altering the energy density of selected foods did not have any effect on consumption of other nonmanipulated foods.

Table 2. *Continued*

Spill et al. (2011)[79]; United States	1 University-based childcare center; 40 children	3–6 y, 4.7 (0.1); boys (47.5%); White (72%), Asian (23%), Black (5%); mean (SD) BMI z-score: boys, –0.1(0.1); girls, 0.5(0.1); mean (SD) BMI percentile, 55.9 (5.1)	Weighing	Energy density	Incorporating vegetables in entrées to reduce the energy density increased total vegetable consumption by children. Also, energy density of entrée was not associated with total weight of food consumed.
Wilson et al. (1991)[80]; United States	1; 40 children	1.67–4.67 y, NR; boys (57.5%); NR; NR	Weighing	Serving chocolate milk	Children consumed more chocolate milk than regular milk. Moreover, consuming chocolate milk did not have any effect on the amount of other food consumption.
Controlled-intervention studies					
Droog et al. (2014)[30]; the Netherlands	6 Primary schools; 160 children (intervention, *n* = 104; comparison, *n* = (56)	4–6 y, NR; boys (51%); NR; normal weight (81%), underweight (12%), overweight (5%), obese (3%)	Proportional consumption	Interactive, shared reading	Children exposed to the carrot-promoting picture book had greater carrot and lower cucumber consumption than the comparison group. Among the children who were exposed to the carrot-promoting picture book, those who were exposed to the interactive shared reading had greater consumption of carrot than the children in the passive shared reading.
Gray et al. (2018)[81]; United States	30; 576 children (intervention, *n* = 327; comparison, *n* = 249)	2–6 y, 3.49 (0.74); boys (52.2%); White (65.6%), Hispanic (19%), other race or ethnicity (15.4%); underweight (5.5%), healthy weight (72.1%), overweight (12.8%), obesity (9.6%)	Observation and structured food record	Lunch brought from home, nonfood reward and nutrition education	Children in the Lunch Bag intervention group ate significantly more vegetables and whole grains than did the control group; however, there was no sustained effect. Also, consumption of chips increased and consumption of sweets decreased in intervention group compared with the control group at the follow-up.

Table 2. *Continued*

Johnson et al. (2019)[82]; United States	5 Rural Head Start childcare centers; 250 children (intervention, *n* = 143; comparison, *n* = 107)	NR, 4.7 (0.4); boys (45.6%); White (82.1%), other race or ethnicity (17.9%); Hispanic/Latino (40.7%), non-Hispanic (59.3%); mean (SD) BMI (kg/m^2), 16.5 (2.4)	Weighing	Teacher-delivered classroom activities	Intake of the target vegetable, jicama, was significantly greater in the intervention group than the control group during postintervention.
Nekitsing et al. (2019)[83]; United Kingdom	11; 140 children (intervention, *n* = 124; comparison, *n* = 16)	2–5 y, 3.18 (0.07); boys (46.67%); NR; NR	Weighing	Taste exposure and nutrition education	Children in the taste exposure group ate more of the target vegetable, *mooli*, than the children in only-taste-exposure group, combined taste-exposure and nutrition education group, and control group. Older children consumed more vegetables than did younger children. In the taste-exposure condition, 10 exposures increased average intake by children by ~10 g, which is 0.25 of a portion.
Nekitsing et al. (2019)[84]; United Kingdom	12 Private childcare centers; 267 children (intervention, *n* = 202; comparison, *n* = 65)	2–5 y, 3.24 (0.04); boys (55.43%); NR; NR	Weighing	Sensory play, congruent and incongruent storybook reading, age	The interventions did not have any effects on the actual consumption of the vegetables. Older children and children with greater baseline intake had greater postintervention consumption.

Table 2. *Continued*

O'Connell et al. (2012)[85]; United States	2 Private childcare centers, 2 CACFP participants; 96 children (intervention, *n* = 43; comparison, *n* = 53)	Age: 3–6 y, NR; boys (56.3%); White (69%), Asian (8%), Black (5%), Hispanic (6%), other race or ethnicity (12%); NR	Weighing	Peer intake and parental feeding practices (namely, restriction, pressure, and monitoring)	Both intake and willingness to try 1 vegetable were associated with those of another vegetable. The intervention group did not have more vegetable consumption compared with the control group. Children's vegetable intake was positively associated with that of their peers, and parental restriction, pressure, and monitoring were not associated with vegetable consumption.
Vandeweghe et al. (2018)[86]; Belgium	2 Flemish nursery schools; 154 children (intervention, *n* = 118; comparison, *n* = 36)	NR, 5.08 (0.61); boys (46.8%); Flemish (100%); NR	Weighing	Repeated exposure, token reward and social reward	Significant condition-by-time interaction was found for consumption of the target food (chicory). All 3 intervention groups had greater consumption and liking of target foods compared with control group at postintervention and follow-up data points. No moderating effect for any of the 3 strategies was found.
Witt et al. (2012)[87]; United States	17 (intervention, *n* = 10; comparison, *n* = 7); 263 children	4–5 y, NR; boys (53%); NR; NR	Plate waste	Teacher-delivered classroom activities, and real food tasting	Children in the Color Me Healthy curriculum intervention group consumed more vegetable and fruit snacks during postintervention and at 3-mo follow-up than did children in the comparison group.
Yin et al. (2012)[88]; United States	4 Head Start centers; 384 children (intervention, *n* = 184; comparison, *n* = 69)	3–5 y, 4.1 (0.56); boys (48%); Hispanic (90%); mean (SD) BMI z-score, 0.70 (1.32)	Aggregated plate waste	Staff training, nutrition-related classroom activities	Children in the intervention groups (both center- and home-based) had increased consumption of fruit, vegetables, and low-fat milk compared with the comparison group at posttest.

Table 2. *Continued*

Yoong et al. (2019)[89]; Australia	25; 395 children (intervention, *n* = 220; comparison, *n* = 175)	2–5 y, 3.5 (1.0); boys (50.38%); NR; NR	Teacher questionnaire	Providing executive support and nutrition guidelines for serving foods and beverages	Children in intervention group consumed significantly more vegetables, whole grains, meat/meat alternates, and had a higher diet-quality score than did children in the control group.
Zeinstra et al. (2017)[90]; the Netherlands	1 Primary school; 99 children (intervention, *n* = 80; comparison, *n* = 19)	4–6 y, 4.8 (0.5); boys (47.5%); Dutch; mean (SD) BMI z-score, –0.22 (1.3)	Plate waste	Role modeling	There was no increase in carrot intake during the 8 repeated exposure interventions. Children in both intervention condition groups (CV and PR) had increased carrot intake during follow-up compared with the control group. There were no differences between the 2 intervention groups.

Abbreviations: BMI, body mass index; CACFP, Child and Adult Care Food Program; CV, convivial eating; DOCC, Dietary Observation in Childcare Center; HEI, Healthy Eating Index; NR, not reported; PR, positive restriction; WC, waist circumference

Table 3. Correlates and their definitions for children's dietary intake in childcare settings

Correlate[a]	Definition	Reference (study design[b])	No association (study design[b])
Child			
Demographics[c]	Child's age, sex	Anzman-Frasca et al. (2012)[51] (WC); Nekitsing et al. (2019)[83] (CIS); Leahy et al. (2008)[68] (WC); Rollins et al. (2014)[44] (CS); Tovar et al. 2019[28] (CS)	Schwartz et al. (2015)[76] (WC)
Anthropometrics[c]	Age-adjusted BMI, waist circumference, weight status, height	Surette et al. (2017)[45] (CS); Rollins et al. 2014[44] (CS); Anzman-Frasca et al. 2012[51] (WC)	Surette et al. (2017)[45] (CS); Fisher et al. (2003)[60] (WC); Leahy et al. 2008[68] (WC); Schwartz et al. (2015)[76] (WC)
Eating behavior	Parent-reported Children's Food Neophobia scale/Child Eating Behavior Questionnaire		Momin et al. (2018)[71] (WC)
Hunger	Baseline hunger, child's energy consumption in the absence of child's self-reported hunger	Rollins et al. (2014)[44] (CS); Fisher et al. (2003)[60] (WC)	
Preference	Liking of food and reporting it as super yummy, yummy, just okay, yucky, and super yucky		Kranz et al. (2011)[42] (CS)
Executive function	Inhibitory control, food-directed reward motivation, approach (a self-regulatory behavior involving heightened feelings of excitement and less impulse control toward food)	Rollins et al. (2014) (WC)[74]; Rollins et al. (2014)[44] (CS)	Rollins et al. (2014)[74] (WC)
Clan			
Parents			
Parental feeding practices	Parent-reported feeding practices of restriction of snacks, pressure, and monitoring	Rollins et al. (2014)[74] (WC)	O'Connell et al. (2012)[85] (CIS); Rollins et al. (2014)[74] (WC)

Table 3. *Continued*

Parent involvement	Engaging parents with childcare settings–based interventions, providing education through in-person meetings, sending newsletters, assigning home-based activities, and providing education and rewards for school-lunch components brought from home	Yin et al. (2012)[88] (CIS); Johnson et al.[82](2019) (CIS); Gray et al. (2018)[81] (CIS)	Parent involvement
Peers			
Peers[c]	Average peer intake (comparing a child's intake with average intake of the other children at his or her table), peer modeling, peer influence	O'Connell et al. (2012)[85] (CIS); Lowe et al (2004)[69] (WC); Ward et al (2017)[48] (CS)	
Childcare teacher			
Feeding Style	Authoritative	Hughes et al. (2007)[40] (CS)	
	Authoritarian	Tovar et al. (2019)[28] (CS)	Hughes et al. (2007)[40] (CS)
	Uninvolved		Hughes et al. (2007)[40] (CS)
	Indulgent	Hughes et al (2007)[40] (CS)	Tovar et al (2019)[28] (CS)
Practices	Overall feeding practices, overall nutrition practices		Vaughn et al. (2017)[46] (CS); Ward et al. (2017)[48] (CS)

Table 3. *Continued*

Responsive feeding practices[c]	Role modeling	Zeinstra et al. (2017)[90] (CIS); Kharofa et al. (2016)[16] (CS); Ward et al. (2017)[48] (CS); Gubbels et al. (2015)[12] (CS)	
	Talk about healthy food		Kharofa et al. 2016[16] (CS)
	Explain food preparation	Gubbels et al. (2015)[12] (CS)	
	Have general conversation	Kharofa et al. (2016)[16] (CS)	
	Verbal encouragement; times staff encouraged to try new foods; stimulation to eat	Gubbels et al. (2015)[12] (CS)	Kharofa et al. (2016)[16] (CS); Ward et al. (2017)[48] (CS)
	Satiety recognition		Ward et al. (2017)[48] (CS)
	Not using food as reward	Ward et al. (2017)[48] (CS)	
	Child involvement in food preparation	Gubbels et al. (2015)[12] (CS)	
	Nonfood reward and social appreciation	Lowe et al (2004)[69] (WC)	Vandeweghe et al. (2018)[86] (CIS)
Controlling feeding practices[c]	Staff gives food or second servings without asking	Gubbels et al. (2015)[12] (CS)	Kharofa et al. (2016)[16] (CS)
	Coercive control	Tovar et al. (2019)[28] (CS)	
	Unhealthy role modeling		Tovar et al. (2019)[28] (CS)
Food provision			
Center menus	Center's weekly menu		Vaughn et al. (2017)[46] (CS)
Foods and beverages served[c]	Foods and beverages served, amount, varieties, and providing dip	Vaughn et al. (2017)[46] (CS); Roe et al. (2013)[73] (WC); Carstairs et al. (2018)[59] (WC); Savage et al. (2013)[75] (WC); Anzman-Frasca et al. (2012)[51] (WC); Hägg et al. (1998)[69] (WC); Norton et al. (2015)[72] (WC)	Yoong et al. (2019)[89] (CIS); Wilson et al. (1991)[80] (WC); Vaughn et al. (2017)[46] (CS)

Table 3. *Continued*

Portion sizes[c]	Portion sizes of milk, snacks, entrée, and experimental menus served to the children	Norton et al. (2015)[72] (WC); Kling et al. (2016)[64] (WC); Kling et al. (2016)[65] (WC); Leahy et al. (2008)[65] (WC); Fisher et al. (2003)[60] (WC); Carstairs et al. (2018)[59] (WC); Smethers et al (2019)[77] (WC)	
Recipe modification			
Food composition[c]	High dietary fiber; macronutrients; amount of salt, fat, and sugar added; major snack component	Branen et al. (2002)[58] (WC); Araya et al. (2003)[54] (WC); Bouhlal et al. (2011)[56] (WC)	Hausner et al. (2012)[63] (WC)
Energy density[c]	Increasing energy density of foods by adding fat or sugar or decreasing energy density by adding vegetables or decreasing fat content	Kling et al. (2016)[64] (WC); Leahy et al. (2008)[66] (WC); Leahy et al. (2008)[68] (WC); Spill et al. (2011)[79] (WC); Leahy et al. (2008)[67] (WC); Araya et al. (1999)[53] (WC); Araya et al. (1983)[52] (WC); Smethers et al. (2019)[78] (WC)	
Shape	Serving cute-shaped snacks	Branen et al. (2002)[58] (WC)	Boyer et al. (2012)[57] (WC)
Classroom			
Curriculum			
Nutrition education[c]	Teacher-delivered classroom-based nutrition curriculum, and classroom-based activities; food education, and mindfulness curriculum	Witt et al. (2012)[87] (CIS); Ward et al. (2017)[48] (CS); Vaughn et al. (2017)[46] (CS); Yin et al. (2012)[88] (CIS); Johnson et al. (2019)[82] (CIS)	Lehto et al. (2019)[43] (CS)
Book reading[c]	Food- and nutrition-related storybook, interactive shared reading, incongruent storybook, character-product congruence	Yin et al. (2012)[88] (CI); Droog et al. (2014)[30] (CIS); Nekitsing et al. (2019)[84] (CIS)	Nekitsing et al. (2019)[84] (CIS)

Table 3. *Continued*

Repeated exposures[c]	Repeated exposures to unmodified, sweetened, fat-added vegetable purees and novel vegetables, food tastes	Vandeweghe et al. (2018)[86] (CIS); Ahern et al. (2014)[49] (WC); Anzman-Frasca et al. (2012)[51] (WC); Ahern et al (2019)[50] (WC); Johnson et al (2019)[82] (CIS); Nekitsing et al. (2019)[83] (CIS); Hausner et al. (2012)[63] (WC); Witt et al. (2012)[87] (CIS); Yin et al (2012)[88] (CIS)	O'Connell et al. (2012)[85] (CIS)
Sensory education	Sensory-based food education, sensory exploration, food manipulation, congruent sensory play, and food-specific tactile exposure		Nekitsing et al. (2019)[84] (CIS); Momin et al. (2018)[71] (WC)
Mealtime environment			
Meal service type[c]	Serving style, staff decides serving style, decide together serving style	Harnack et al. (2012)[62] (WC); Kharofa et al. (2016)[16] (CS)	Schwartz et al. (2015)[76] (WC)
Feeding environment	Total EPAO score for scale overall nutrition environment, total EPAO score for feeding-environment subscale, group size	Vaughn et al. (2017)[46] (CS); Lumeng et al. (2007)[70] (WC)	Vaughn et al. (2017)[46] (CS)
Community			
Childcare settings			
Type of childcare programs	Public vs nonpublic childcare settings; CACFP participation, Head Start centers	Kakietek et al. (2014)[41] (CS)	
Childcare staff[c]	Training childcare staff, psychosocial (perceived influence about availability and concern about fruits and vegetables intake), and cooperation challenges with catering services and other staff	Bell et al. (2015)[55] (WC); Vaughn et al. (2017)[46] (CS); Lehto et al. (2019)[43] (CS)	Lehto et al. (2019)[43] (CS); Yoong et al. (2019)[89] (CIS)
Type of food preparation equipment	Whether the kitchen has onsite facilities for food preparation	Lehto et al. (2019)[43] (CS)	

Table 3. *Continued*

Country		
Policy	Center's written food- and nutrition-related policy, compliance with government policy	Vaughn et al. (2017)[46] (CS); Lehto et al. (2019)[43] (CS); Kakietek et al. (2014)[41] (CS)

[a]No correlate was identified for the cell and culture ecological levels in this review.

[b]CACFP participant, 87.7%; Head Start centers, 68.9%; Eat Well Play Hard centers, 39.6%; no. of children: 636.

[c]These correlates have been investigated in ≥ 3 studies.

Abbreviations: CIS, controlled intervention study; CS, cross-sectional study; EPAO, Environment Policy Assessment and Observation; WC, pre-post intervention study (without control group)

Results

Study selection

Figure 1 is the study selection flowchart. It shows the step-by-step article selection procedure and rationale for exclusion. We followed PRISMA guidelines for study selection. A total of 2438 articles were identified, of which 879 were duplicates and so were removed; an additional 1311 were excluded in the title and abstract screening. The remaining 248 articles were reviewed in full text to see if they met the study inclusion or exclusion criteria (Figure 3). Of these, 55 articles met the complete inclusion criteria and were included in this review.

Study details

Table 2 summarizes the basic characteristics of the 55 articles included in the review. Most of the studies (n = 42) were published after 2010.[12,16,28,30,41–51,55–57,59,62–65,71–79,81–90] More than half of the studies (n = 32 studies; 58%) were conducted in the United States[16,28,40–42,44,46,51,57,58,60,62,64–68,70–82,85,87,88]; 3 were conducted in the Netherlands[12,30,90]; 5 in the United Kingdom[49,50,59,69,83,84]; 3 studies each in Canada[45,47,48] and in Chile[52–54]; 2 in Australia[55,89]; and 1 each in Belgium,[86] Denmark,[63] France,[56] Sweden,[61] and Finland.[43] In terms of study design, 12 were cross-sectional studies,[12,16,28,40–42,44–48,74] 32 were pre-post intervention studies without a control group,[49–51,55–57,59,62–65,71–75,77,78] and 11 were controlled intervention studies.[30,81–90] Sample sizes ranged from a small-scale pre-post intervention study[72] without a control group conducted in 1 childcare setting (n = 26 children) to a large cross-sectional study conducted with 106 childcare settings (n = 636 children).[41] Forty-three studies were conducted in childcare centers,[12,16,40–42,44,45,47,48,51–53,55,57,58,60–62,64–68,70–85,87–89] 2 were in family childcare homes,[28,46] 6 were in nurseries (the term used for childcare centers in the United Kingdom),[49,50,56,59,63,86] and 4 studies were conducted in primary schools.[30,43,69,90] Five were conducted in CACFP-funded childcare settings,[16,28,41,46,85] 7 studies were conducted in Head Start childcare centers[92] (a US federally funded early care and education program for children from low-income families that participates in CACFP),[16,40,41,62,76,82,88] and 11 studies were conducted in university-based childcare centers.[44,51,58,60,66–68,70,72–74] The reported age range of children in these studies was between 1 and 7 years. In 29 articles, authors reported weight status as mean weight,[53] body mass index (BMI),[48,59,82] BMI z-score,[1,6,50,54,56,61,64,77–79,88,90] BMI percentile,[62,65–68,72–74,79] and/or percentages of overweight or obesity[30,47,81]; 25 studies did not report child weight status.[12,28,40–43,46,49,53,55,57,58,60,63,69–71,75,80,83–87,89]

The measures used in each study are listed in Table 2. Of the 55 studies, researchers measured only fruits and/or vegetables consumption in 19[16,30,43,50,51,59,63,68,69,73,75,79,81,83–87,90]; snacks and dessert consumption was measured in 9 studies[42,44,53,57,58,70–72,74]; in 28 studies, researchers measured consumption from multiple food groups.[12,16,28,40,45–48,52–55,59,61,62,64–68,76–81,88,89] In 1 study, only beverage consumption was measured,[41] and in another, only entrée (i.e., the main cooked meal, such as sandwich, pasta, rice, and curry) consumption was measured.[60] In most studies, researchers measured children's dietary intake by weighing (n = 31)[40,48–54,56,59–61,63–68,72–75,77–80,82–86] and plate-waste methods (n = 14)[40,42,45,48,55,57,65–69,87,88,90]; 4 studies used childcare teacher records, including 1 teacher-reported food frequency questionnaire[16,28,46,69,70]; 4 studies used dietary observation in the childcare center; 2 studies used

digital photography[47,48]; 5 studies used visual estimation and observation[41,58,69,70,81]; and 1 study used recordings by researchers, along with weighing[56] (Table 2).

Risk-of-bias summary

Cross-sectional study

Of the 12 observational studies identified, all had moderate risk of bias. Common strengths of the reviewed studies included describing the eligible population,[12,16,40,42–45,47,48] sample size,[41,45] data collection points,[42,47] and methods used to measure variables.[12,16,28,40,42–48] Common weaknesses included not acknowledging small sample size, unclear defined variables, and use of a cross-sectional rather than a longitudinal design. In no studies was the assessor blinded to the exposure conditions, and no study had a follow-up condition. Four studies did not control for potential important covariates.

Pre-post study (without control group)

Of the 32 prepost studies, 11 had low risk of bias, 18 had moderate risk, and 3 had high risk. Common strengths included sample-size justification,[49,52,53,55,56,59,63,66,68,69,71,73,77–79] clear description for intervention, whether the intervention was consistently delivered,[49–59,61–75,77,78,80] blinding[56,70] < 20% of loss to follow up,[49–51,53,54,56,59,63,64,67,70–75,77–80] and conducting appropriate statistical analyses.[49–51,56,57,63,64,66–68,70–75,78,79]

Common weaknesses included having 2 data collection points (baseline and postintervention), a small sample size, and not including individual-level data in the analysis. Specifically, 7 studies had > 2 data points, the assessor was blinded to the exposure condition in 2 studies; and *P* values or confidence intervals for analyses of changes were not provided in 1 article. Ten studies had a small sample or small effect size or were conducted in only 1 childcare setting. Four studies did not provide sample-size justification.

Controlled intervention study

Of the 11 intervention studies with a comparison group, 3 had low risk of bias and 8 had moderate risk of bias. Common strengths for these studies included randomization,[81,83,85,87] group assignments,[30,83–87,89] blinding,[82,89] similar baseline characteristics between groups,[30,81,83–90] high adherence to protocols, and consistent outcomes assessments across groups.[30,76,81–90] Common weaknesses included convenience sampling, no mention of intention-to-treat analysis, small sample size, and not avoiding other or similar interventions. In 9 articles, authors mentioned randomization; however, authors of 5 studies explained the process adequately. Two studies reported complete or partial blinding of the assessors.[82,89] The presence of baseline differences between groups was reported in 1 study, and in 2 others authors did not report baseline differences between groups at all. Three studies had a small sample, and 5 studies did not report sample-size calculation. In addition, authors of 1 of the articles mentioned the potential chance of similar intervention exposures in the comparison group.

Correlates of children's dietary intake in childcare settings

A total of 29 correlates were classified into 4 levels: child (i.e., child's individual characteristics), clan (i.e., characteristics of parents, peers, childcare teachers, food provision, classroom, mealtime environment), community (i.e., characteristics of childcare settings and childcare staff), and country (i.e., governmental- and childcare-level written policies). In the majority of the studies (n = 45), researchers assessed 1–3 correlate(s); in the remaining 10, researchers assessed 4–7. Table 3 provides a summary of the associations between correlates of children's dietary intake in childcare settings along with definitions and ecological level for each correlate.

Child: personal characteristics

Demographics. In 3 studies (1 cross-sectional, 1 pre-post, and 1 controlled intervention study), authors reported that older children had greater consumption of vegetables[51,84] and snacks[44] than did younger children. In 2 cross-sectional studies and 1 pre-post study, authors noted boys had greater consumption (total weights) of foods, beverages, and snacks than did girls[28,44,68]; in another pre-post study, the authors reported null effect of sex.[76] No studies examined associations between child race or ethnicity or socioeconomic status and children's dietary intake in childcare settings.

Anthropometrics. The evidence linking children's BMI and dietary intake in childcare settings was mixed. No association was found in 3 pre-post studies.[60,68,76] In 1 pre-post study and 1 cross-sectional study, a negative association between BMI and plate waste[45] and vegetable consumption was found[51]; in another cross-sectional study, researchers found a positive association between BMI and snack consumption.[44] Waist circumference was not correlated with plate-waste amount in a cross-sectional study.[45]

Hunger. Children who eat in the absence of hunger[44] and children who have higher baseline hunger[60] have greater dietary intake than other children. These relationships were found in 1 cross-sectional[44] and 1 prepost study,[60] respectively.

Executive function. In 1 cross-sectional study and 1 pre-post study, researchers found that less inhibitory control[44] and relative reinforcement value for food[44,74] were positively correlated with greater consumption of snacks. The potential correlate "approach towards foods"[44,74] (defined as a self-regulatory behavior involving heightened feelings of excitement and less impulse control toward food) was not noted as a significant correlate of dietary intake.[44,74]

Summary of child-level correlates

Eating behavior[71] and food preferences[42] were examined in 1 study each, with authors reporting null findings. Child's age and sex were correlates of dietary intake. There was unclear evidence for weight status and dimensions of executive functions as correlates of dietary intake. Moreover, there was insufficient evidence for hunger, preference, eating

behavior, and waist circumference as correlates for children's dietary intake in childcare settings.

Clan: parents, peers, childcare teacher, food provision, classroom, mealtime environment

Parents. Parental Feeding Practices. In 2 controlled intervention studies, researchers found parent-reported feeding practices were not related to children's dietary intake in childcare settings.[74,85] Authors of a controlled intervention study noticed that parents' feeding practices of restricting certain foods predicted greater overall food consumption in childcare.[74]

Parent Involvement. In 1 pre-post study and 2 controlled intervention studies, parents were included as part of the multilevel intervention. In all 3 studies, authors reported significantly improved dietary intake among children in the intervention group.[81,82,88]

Peers. Average peer intake was positively correlated with target vegetable consumption in a controlled intervention study[85] and with total amount of food consumption in a cross-sectional study.[47] In addition, in another controlled intervention study,[69] remote peer-modeling interventions, using videos, was associated with greater consumption of fruits and vegetables.

Childcare teacher. Feeding Style. Indulgent feeding was positively associated with dietary intake[40] in 1 cross-sectional study and negatively associated in another cross-sectional study.[28] Dairy intake was positively associated with authoritative feeding style in 1 cross-sectional study.[40] Uninvolved feeding style was not associated with dietary intake in 2 cross-sectional studies.[28,40]

Practices. Overall and composite scores for feeding and nutrition practices were not associated with children's dietary intake in 2 cross-sectional studies.[46,48]

Responsive Feeding Practices. Responsive feeding practices and their association with children's dietary intake were investigated in 4 studies. Role modeling was positively associated with children's vegetable consumption in 1 controlled intervention study[90] and in a cross-sectional study.[16] In addition, role modeling was positively associated with sugar intake in 1 cross-sectional study.[48] Talking about healthy food was not associated with children's dietary intake, and having nonfood-related general conversation was negatively associated with vegetable consumption in 1 cross-sectional study.[16] Explaining food preparation was positively associated with fruit consumption in another cross-sectional study.[12]

Verbal encouragement and providing stimulation to eat were positively associated with increased dietary intake in 1 cross-sectional study[12]; however, in 2 other cross-sectional studies, researchers found no association.[16,48] No association between hunger and satiety recognition with children's dietary intake was found in 1 cross-sectional study, and not using food as a reward was associated with reduced dietary intake in the same study.[48] For praises and nonfood rewards, authors of a pre-post study reported null findings for an association with vegetable consumption,[86] whereas authors of another cross-sectional study found positive associations between nonfood rewards and fruit and vegetable

consumption.[69] Less consumption of sweet snacks was positively associated with child involvement in food preparation in a cross-sectional study.[12]

Controlling Feeding Practices. Three cross-sectional studies investigated links between controlling feeding practices and children's dietary intake. No association was reported between giving children food unprompted by their hunger cues and child dietary intake.[16] Coercive-control feeding was negatively associated with children's dietary intake in 1 study,[12] whereas in another, authors reported no association.[28] Last, in 1 study, authors found unhealthy role modeling was not related to children's dietary intake.[28]

Food provision. Foods and Beverages Served. Serving foods from a variety of different food groups was related to children's dietary intake in 1 cross-sectional study and 1 controlled intervention study.[46,89] In 2 pre-post studies in which researchers investigated the effect of serving target fruits and vegetables during snack time and of serving a variety of vegetables instead of a single type per week, a positive association with dietary intake was reported.[59,73] Serving flavored or unflavored dip was positively associated with vegetable intake in 2 other pre-post studies.[51,75]

Beverage consumption was not associated with children's dietary intake in 1 cross-sectional study[46] and 1 pre-post study.[80] However, in 2 other pre-post studies, serving milk and juice was negatively correlated with dietary intake compared with serving water.[61,72]

Portion Sizes. Serving larger portions of beverages and entrées was positively associated with greater consumption of that beverage or entrée in 4 pre-post studies.[60,64,65,72] In addition, in 3 pre-post studies, researchers reported that larger entrée portion sizes were positively associated with the greater consumption of that entrée, but there was no change in consumption of vegetables or other food groups.[59,64,66]

Recipe modifications. Food Composition. Recipe modifications such as increasing dietary fiber of snacks (e.g., including fruits and whole-grain snacks) and adding salt were positively associated with child snack, vegetable, and entrée consumption in 2 pre-post studies.[56,58] Authors of another pre-post study reported greater carbohydrate content was associated with a greater amount of dietary intake during the subsequent meal compared with a meal containing a higher amount of protein.[54] Adding fat to vegetables and sugar to fruit purees resulted in null findings in 2 pre-post studies.[56,63]

Energy Density. In 2 articles published before 2000 on pre-post studies, energy density (rice vs. mixed-vegetable soup) was negatively associated with dietary intake.[52,53] In 6 more recent pre-post studies, published from 2008 to 2019, recipe modifications, such as increasing energy density by adding sugar and fat content or reducing energy density by incorporating vegetables within the entrée, were not associated with children's total dietary intake.[64,66–68,78,79] However, adding vegetable purees to the entrée was associated with greater total vegetable intake in 2 of these pre-post studies, though this action was not correlated with children's dietary intake from other food groups.[60,65]

Shape. Serving cute or different-shaped snacks was positively associated with children's snack consumption in 1 pre-post study[58] but was not associated with snack consumption in another pre-post study.[57]

Classroom

Curriculum

Nutrition education. In 3 controlled intervention studies, teacher-delivered nutrition education curriculum interventions (Color Me Healthy[87]; Sesame Street Workshop Healthy Habits for Life[88]; Food Friends—Fun With New Foods[82]) were positively associated with vegetable and other target food consumption. Classroom-based activity intervention and actual food tasting, along with nutrition-related curriculum interventions, also were positively related with increased consumption of fruits and vegetables.[82,87]

Of 3 cross-sectional studies, positive associations between teacher-delivered planned nutrition- or food-related education for children and children's dietary intake were found in 2[46,48]; in the third study, authors reported a null finding.[43]

Book reading. Congruent story reading—an intervention involving reading stories to children with pictures and plots that are relevant for a target vegetable or fruit—was associated with increased consumption of the target vegetable or fruit in 3 controlled intervention studies.[30,84,87] In contrast, incongruent story reading (i.e., in which the pictures or plots do not relate to a target vegetable or fruit) did not result in increased vegetable consumption.[84]

Repeated exposure. Repeated exposures to (n = 5–10) and tastings of unmodified or vegetable purees combined with applesauce and of novel vegetables were positively related with vegetable consumption in 5 controlled intervention studies and 4 pre-post studies.[49–51,63,82,83,86–88]

Sensory education. In 1 controlled intervention and 1 pre-post study, authors found no effect of sensory play and sensory manipulation of foods on dietary intake.[71,84]

Mealtime environment

Meal Service Type

Fruit and vegetable consumption was greater during family-style meal service compared with teacher-portioned and preplated meals in a prepost study[62] and compared with parent-provided meal services in 1 cross-sectional study.[16] Serving fruits and vegetables first during family-style meal service, compared with traditional family style, was correlated with greater intake of fruits in a pre-post study[62]; however, authors of another pre-post study reported no significant differences.[76] Teacher-portioned serving style was associated with greater consumption of grains, meat, and milk and lower intake of fruits and vegetables than with family-style meal service in a pre-post study.[62]

Feeding Environment

Children's group size at the table was positively associated with snack consumption in 1 pre-post study.[70] In another cross-sectional study in which researchers used the Environment Policy Assessment and Observation tool to assess the childcare nutrition environment the tool's scale "Overall Nutrition Environment" was positively associated with children's healthful dietary intake; however, the subscale "Feeding Environment" was not associated with healthful dietary intake.[28]

Summary of clan-level correlates

Parental involvement, variety of foods and types of beverages served to the children, recipe modifications, portion size, nutrition education, repeated exposure, peer influence, meal service type, and childcare teacher's role modeling were clan-level correlates of children's dietary intake. Whether parental feeding practices and beverage consumption are correlates of children's dietary intake is unclear because of the mixed findings. In addition, center menu, shape of snacks, sensory education, rewards, feeding environment, feeding style, and controlling feeding practices had insufficient evidence to be considered correlates of children's dietary intake.[46]

Community: childcare settings

Childcare staff. Childcare staff included kitchen staff, cooks, center directors, and managers who do not have direct contact with the children. Providing professional development for childcare staff about menu preparation, nutrition, and hygiene were all positively associated with children's dietary intake in 2 cross-sectional studies and 1 pre-post study,[43,46,55] whereas in an article about a controlled intervention study, authors reported a null finding.[89]

Authors of a cross-sectional study reported mixed findings about the association between child fruit and vegetable consumption and staff psychosocial factors and organizational challenges.[43] In that study, having at least 2 organizational challenges with catering services was associated with lower fruit intake. Food education, lack of resources as a barrier to healthy nutrition, concern about consumption of fruits and vegetables, perceived influence about fruits and vegetables supply, and psychosocial factors were not associated with consumption of fruits and vegetables.[43]

Summary of community-level correlates

The following correlates in the community-level category were reported in 1 study each: the types of food preparation equipment available[43] and the type of childcare programs (e.g., CACFP participation, Head Start, childcare participating in a nutrition intervention).[41] Thus, there was not enough evidence to assess whether these factors may be linked to child dietary intake. Childcare staff characteristics and professional development training intervention for the staff appear to be correlated with dietary intake in childcare settings.

Country: policy

In 2 cross-sectional studies, authors found that childcare centers that have written policies about food and nutrition practices were positively associated with children's dietary intake.[43,46] Childcare centers' degree of compliance with governmental policies including Head Start and CACFP, as well as state-level policies about dietary intake were associated with less consumption of sugar-sweetened beverages by children and greater intake of low-fat (< 1%) milk, but no association was reported between policy compliance and water intake in another cross-sectional study.[41]

Discussion

In this systematic review, we investigated correlates for children's dietary intake in childcare settings and organized the correlates using the Six-Cs developmental ecological model. We found no cell-level and culturelevel correlates of children's dietary intake. Child-level factors identified child's age and sex as correlates. Clan-level factors identified parental involvement in the intervention; types and composition of foods served; portion sizes; recipe modifications; repeated exposure; nutrition education; book reading; peer influence; meal service type; and childcare teachers' role modeling. Last, professional development training of childcare staff and policy were correlates at the community and country levels, respectively. However, children's anthropometrics; executive function; parental feeding practices; food shape; energy density of foods; sensory education; using food as reward; teachers' controlling feeding practices; feeding style; feeding environment; and type of childcare program had mixed or insufficient evidence for a conclusion to be drawn.

Among 55 included studies, vegetable consumption was reported as the primary outcome in 16. Given that 9 of 10 young children in the United States do not meet dietary recommendations for vegetable consumption,[93] CACFP requires childcare teachers to serve vegetables along with fruits to children to ensure vegetable availability.[4] However, the consumption of vegetables remains lower than the recommended amount[5,6] and childcare teachers express concerns over children's refusal of vegetables.[94] It is important to note that in this systematic review, we identified several factors associated with increased vegetable consumption that can be targets of childhood obesity prevention interventions. Together, findings suggest that family-style meal service, role modeling, repeated exposure to vegetables, serving condiments with vegetables, and modest alterations of recipes (e.g., adding salt) may be effective strategies to promote more vegetable consumption by preschoolers.[16,30,43,50,51,59,62,63,68,69,73,75,79,81,83–87,90] Furthermore, because providing extra servings of preportioned vegetables increases plate waste, incorporating target vegetables into the entrée could be a promising strategy to reduce plate waste[85] during the intervention.

Portion size was positively associated with more entrée consumption in 7 studies. Preselected portion sizes increased children's entrée consumption. In addition, children with lower sensitivity to satiety and higher baseline hunger consumed more entrées and snacks than did other children.[57,59] Therefore, responsive feeding practices, such as allowing children to self-select portions (i.e., family-style meal service) and teaching children about self-regulating their dietary intake in childcare settings may prevent overeating.[44,74,95] In support of this research, family-style meals whereby children serve themselves and select their

portions are widely recommended by national programs and policies such as Head Start, CACFP, and Academy of Nutrition and Dietetics.[3,92,96] Results of this review also suggest that childcare teachers can promote children's healthier food intake by practicing role modeling healthy eating (sitting and eating the same foods as children during mealtimes), foster peer modeling, involve children in food preparation, and provide curriculum-based nutrition education during classroom routines to encourage children to try healthier foods.[95,97–99] Therefore, if childcare programs cannot practice family-style meal service (e.g., in the event of infections in childcare or public health crisis necessitating social distancing and other health or safety policy changes), they could still implement responsive feeding practices with preplated meal service to promote consumption of healthier foods and support child self-regulation.[98,100] Also, engaging and educating parents about nutrition-related best practices and focusing on improving parents' knowledge and attitude toward these practices had a synergistic effect on promoting children's healthy dietary intake in childcare.[81,82,88]

Previous research has emphasized the significance of Head Start and CACFP programs for better provision of healthier foods and increased implementation of responsive feeding practices in childcare settings.[101–106] However, we only found 1 study in which researchers examined the relationship of CACFP and Head Start participation with children's beverage consumption,[41] and we found no other studies related to food consumption. Given that the children participating in CACFP and/or attending Head Start are from low-income families who are more likely to have excess weight and not meet dietary recommendations, compared with children from middle- and higher-income families, identifying the impact of the federal programs on low-income children's dietary intake is a major research gap.[107–109]

On the basis of the findings of this review, we can offer policy implications for childcare program nutrition standards to improve children's dietary intake. For example, CACFP may consider reimbursing childcare programs for serving healthy dips with vegetables and providing meals for adult caregivers so that they can eat the same foods served to children during mealtimes to role model promoting children's consumption of healthier foods. CACFP offers a range of nutrition topics for professional development of childcare staff; however, on the basis of the findings of the present review, targeted training on child's nutrition, menu preparation, and nutrition education[43,46,55] could benefit all childcare programs in improving children's consumption of healthier foods. Finally, nutritional policies regarding the use of salt and condiments in food preparation may take these findings into account and allow limited addition of salt in foods that are less preferred by the children (e.g., vegetables).

Because no studies in the present review considered children's socioeconomic status and racial or ethnic differences, we were unable to determine these factors as potential correlates. This is a concerning knowledge gap, given that approximately 52% of low-income children in the United States attend childcare[110] and are at an increased risk of obesity and health disparities,[111] and dietary intake of specific food groups widely varies among children from different ethnic and cultural groups.[112] Past research has shown that home-based childcare settings[113,114] and childcare settings in rural areas[115] have lower access and more barriers to serving healthy foods than do center-based childcare settings and their urban counterparts. However, home-based childcare setting was highly underrepresented

in this review (only 2 studies were conducted in a home-based setting), and geographic location was not considered as a correlate in any study. In addition, although we found providers' responsive feeding practices, such as role modeling as correlate of children's dietary intake, in recent studies, researchers have started to question the ability of childcare teachers to serve as role models when the majority of childcare teachers are overweight or obese and at increased risk of health disparities.[116–118] Last, we found a dearth of studies exploring celland culture-level correlates for children's dietary intake. Consequently, research is needed to examine the impact of cell- and culture-level factors, children's and providers' sociodemographic variables, home-based childcare, geographic location of childcare setting, and childcare staff health and well-being on children's dietary intake.

Regarding strength of the evidence presented in this systematic review, the correlates should be considered on the basis of the types of study design used in the reviewed study. The following correlates were derived from controlled intervention studies: parent involvement, peer modeling, variety of food groups, nutrition education, congruent story reading, and repeated exposures. Correlates derived from pre-post design studies include child's age, sex, meal service type, composition, and portion sizes of foods. The following correlates were derived from cross-sectional studies: childcare teachers' responsive feeding practices, childcare staff training, and policy. Although the intervention studies we reviewed provided important insights about children's dietary intake and associated factors in childcare settings, most of the included intervention studies (n = 32 of 43 intervention studies) targeting children's dietary intake as the primary outcome were pre-post design studies lacking a control group, did not report follow-up data, and had a small sample size with limited generalizability.[91] Moreover, authors of the controlled intervention studies included in this systematic review did not provide information about power analysis to determine sample size, description of randomization, or intention-to-treat analysis.[91,119] Therefore, experimental studies with stronger research designs are needed to establish causal relationship between potential correlates detected in pre-post and cross-sectional studies, and researchers should report study methods and strength of the evidence using published tools such as the National Heart, Lung, and Blood Institute Study Quality Assessment tool and the Consolidated Standards of Reporting Trials statement.[91,119]

The present review's methodology was characterized by the following limitations. First, to limit the scope of our review, we were unable to include energy (caloric), fiber, or individual macronutrient and micronutrient consumption as potential outcomes. Second, most of the studies reviewed were published in the United States and study inclusion was limited to those studies published in the English language. Thus, international studies may have been missed and the findings may not be representative of international childcare programs. Third, given the breadth of studies included and the vast number of dietary consumption measures within the literature, we opted to focus on providing a qualitative synthesis, so we were unable to evaluate quantitative effect sizes of specific correlates. Thus, in future meta-analyses, researchers may consider the correlates of dietary intake identified in this review, but such analyses were beyond the scope of the this review.

Conclusion

Dietary intake by preschool children in childcare settings is an important risk factor for childhood overweight and obesity. We investigated correlates of child dietary intake in childcare settings that can be a target for obesity prevention interventions, and we identified several gaps in the multiple levels of the Six-Cs developmental ecological model. Additional research is warranted to study potential correlates of dietary intake at the cell, country, and culture levels, because the majority of the studies have focused on the clan- or classroom-level correlates. Specifically, given the importance of the federal nutrition assistance programs, studies are warranted to examine the relationship between childcare settings' participation in and adherence to national nutrition standards and children's dietary intake. Findings in the present study showed that parental involvement with the teachers in interventions at childcare settings may lead to better implementation of intervention strategies. Childcare teachers also play a crucial role in childhood obesity prevention intervention by practicing family-style meal service, role modeling, repeated exposure, recipe modifications, and providing nutrition education in childcare settings.

Acknowledgments – The authors thank Dr. Erica DeFrain for providing technical assistance in the project for literature search and Dr. Madeleine Sigman-Grant for providing editorial assistance and scientific writing expertise in the project. The authors appreciate the time and efforts contributed by Nicole D. Jonson and Jasmin A. Smith as double coders in this project.

Funding – This work was supported by the US Department of Agriculture National Institute of Food and Agriculture Hatch Project grant 1011204; the Nebraska Agricultural Experiment Station, Nebraska Extension; and Betti and Richard Robinson Professorship funds (to D.A.D.).

Author contributions – S.H. led the review, was responsible for managing the project, and drafted the report. J.A.S. provided expert advice on methodology. J.A.S. and D.A.D. provided expert advice on systematic reviews, made critical comments that helped in the interpretation of results, helped write sections of the report, and reviewed the final report.

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Declaration of interests – The authors have no relevant interests to declare.

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Supplemental Information

Appendix S1. Keyword search strategy
Keywords "factors" OR "causes" OR "influences" OR "reasons" OR "determinants" OR "predictors" OR "predisposition" OR "risk" OR "characteristic" OR "causal" OR "effects" OR "association" OR "outcome" OR "Increase" OR "decrease"
Combined with each of the following: *And:* "intake" OR "consumption" OR "pattern" OR "behavior" OR "habit" OR "preference" OR "choice" *And*: "diet*" OR "food" OR "meal*" OR "nutrition" OR "eating" *And*: "child care" OR "childcare" OR "day care" OR "preschool" *And*: "children" OR "toddlers" OR "preschoolers" *Not*: "adolescents" OR "teenagers" OR "adult" OR "elderly" OR "senior" *Not*: "qualitative" OR "systematic review" OR "focus group" *Not*: "defects" OR "ADHD" OR "allergy" OR "disorders" OR "illness" OR "autism"

Table S1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a literature review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known about your topic.	3, 4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5, 6
METHODS			
Eligibility criteria	5	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5, 6, 7 and Figure 2
Information sources	6	Describe all information sources (e.g., databases with dates of coverage) in the search and date last searched.	4
Search	7	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	7
Study selection	8	State the process for selecting studies (i.e., screening, eligibility).	7, 8, 9 and Figure 2
Risk of bias in individual studies	9	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level).	9
Risk of bias across studies	10	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	9
RESULTS			
Study selection	11	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	9, 10, 11, Figure 3
Study characteristics	12	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 1
Synthesis of results of individual studies	13	For all outcomes considered (benefits or harms), present, for each study: (a) summary of results and (b) relationship to other studies under review (e.g., agreements or disagreements in methods, sampling, data collection or findings).	Table 1, Table 2, and page 9–21

DISCUSSION			
Summary of evidence	14	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	21–-26
Limitations	15	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	25, 26
CONCLUSION			
Conclusions	16	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	26